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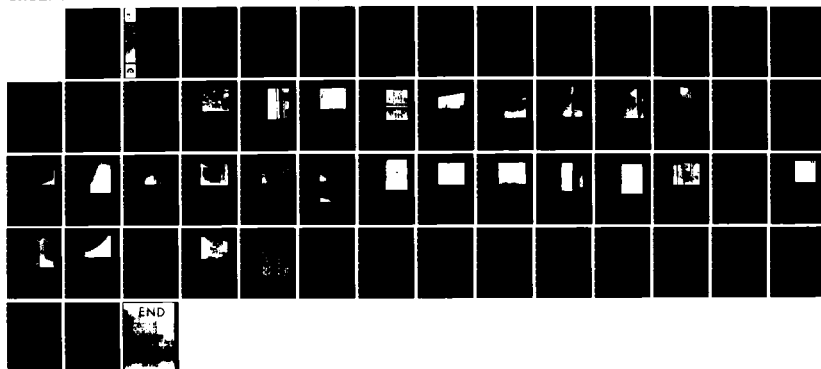
HOW TO AVOID DEFICIENCIES IN PORTLAND-CEMENT PLASTER  
CONSTRUCTION(U) ARMY ENGINEER WATERWAYS EXPERIMENT  
STATION VICKSBURG MS STRUCTURES LAB J W RIBAR ET AL.  
JUN 84 WES/TR/SL-84-10

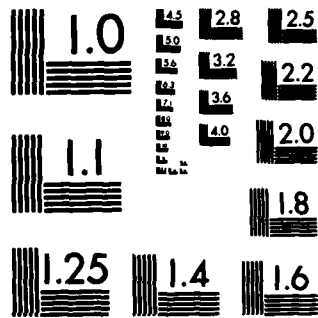
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TECHNICAL REPORT SL-84-10

# HOW TO AVOID DEFICIENCIES IN PORTLAND-CEMENT PLASTER CONSTRUCTION

by

Jacob W. Ribar

Construction Technology Laboratories  
5420 Old Orchard Road  
Skokie, Illinois 60077

and

John M. Scanlon

Structures Laboratory

DEPARTMENT OF THE ARMY  
Waterways Experiment Station, Corps of Engineers  
PO Box 631  
Vicksburg, Mississippi 39180



AUG 27 1984

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June 1984

Final Report

Approved For Public Release. Distribution Unlimited

Prepared for

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Washington, DC 20314

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report documents the results of a task force assessment of deficiencies in portland-cement plaster construction being performed for the Corps of Engineers. A field survey of various civil works and military projects revealed 28 repetitive deficiencies for which causes are cited. Recommendations for prevention and possible repair procedures are presented in a series of fact sheets included in the report. +		

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## Preface

This report was prepared at the Structures Laboratory (SL) of the US Army Engineer Waterways Experiment Station (WES), under sponsorship of the Director of Engineering and Construction, Headquarters, US Army Corps of Engineers (HQUSACE), as requested by appropriation 2132050 (MCA) on 15 July 1983. The work consisted of a task force assessment of deficiencies in architectural concrete construction and in portland-cement plaster construction being performed for the Corps of Engineers. This report presents the results of the work on portland-cement plaster construction.

The work was conducted under the general supervision of Mr. Bryant Mather, Chief, SL, WES, and under the direct supervision of Mr. John M. Scanlon, Chief, Concrete Technology Division, SL, who served as Task Force Manager. In addition to Mr. Scanlon, members of the task force were Mr. Lou Tinnerello, DAEN-ECE-DC, who also served as Technical Monitor for HQUSACE; Mr. Michael Nash, Concrete Consultant to Al Batin District, Middle East Division (Forward); Mr. Joseph A. Dobrowolski, an industry architectural concrete consultant; and Mr. Jacob W. Ribar, an industry portland-cement plaster consultant. This report was prepared by Messrs. Scanlon and Ribar.

Commander and Director of WES during the preparation of this report was COL Tilford C. Creel, CE. Mr. F. R. Brown was Technical Director.



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Conversion Factors, Non-SI to SI (Metric)

Units of Measurement

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
feet	0.3048	metres
inches	0.0254	metres
square feet	0.09290304	square metres



HOW TO AVOID DEFICIENCIES IN PORTLAND-  
CEMENT PLASTER CONSTRUCTION

Introduction

1. MG A. S. Albro, Director of Engineering and Construction, Headquarters, US Army Corps of Engineers (HQUSACE), has for many years recognized that too many deficiencies have been occurring in architectural concrete and portland-cement plaster construction being performed by contractors working for the Corps of Engineers. These deficiencies have been noted on civil works construction projects as well as in military construction, and they have occurred in the Continental United States (CONUS) as well as in Saudi Arabia, Europe, Jordan, and the Far East. These deficiencies do not appear to be limited by conditions of climate, environment, or construction expediency; rather, they occur universally.

2. In an attempt to correct some of the causes of these deficiencies, MG Albro directed that the Waterways Experiment Station (WES):

- a. Appoint a manager for a task force to be comprised of a WES representative, a HQUSACE representative, a Middle East Division (Forward) representative, an industry architectural concrete consultant, and an industry portland-cement plaster consultant.
- b. Contract with industry experts in the architectural concrete and portland-cement plaster fields to assess state-of-the-art information on these subjects and prepare documentation of their assessments.
- c. Organize site visits by the task force to Saudi Arabia, Jordan, and various CONUS locations to inspect appropriate projects, interview associated personnel, and review contractor and government project documentation.
- d. Canvass industry for currently available written information and evaluate its applicability to accomplishing task force objectives.
- e. Identify new products and new materials being used in Saudi Arabia, Jordan, and CONUS and cite advantages and disadvantages of each for potential use and indicate where future product qualification is needed.
- f. Assimilate all field data, evaluations, and documentation and then prepare a report of recommended actions necessary to accomplish task force objectives. Upon HQUSACE approval, prepare necessary handbooks, specification changes, and a construction inspector's guide.

3. The following schedule was established:

- |  |           |
|--|-----------|
| <u>a.</u> Establish funding; task WES  | 18 Jul 83 |
| <u>b.</u> Complete field phase   | 1 Sep 83  |
| <u>c.</u> Complete report of field phase and<br>brief Deputy Director of Engineering<br>and Construction and staff | 15 Sep 83 |
| <u>d.</u> HQUSACE approval of field phase report   | 22 Sep 83 |
| <u>e.</u> Complete documents and brief Director<br>of Engineering and Construction and staff                       | 1 Nov 83  |

4. This report presents a discussion of the deficiencies found during the field investigations which are considered to be representative of deficiencies in portland-cement plaster construction currently being undertaken by the Corps of Engineers. Causes of these deficiencies, measures which can be taken to avoid such deficiencies, identification of new products and procedures, and recommended repair techniques are discussed herein.

### Scope of Field Investigation

5. The field phase of the investigation included visits to the following projects:

- a. Orleans Marina-Lake Pontchartrain Floodwall System, New Orleans, LA.
- b. Algiers Point Floodwall, New Orleans, LA.
- c. Gretna Ferry Landing Floodwall, New Orleans, LA.
- d. Tiger Island Floodwall System, Morgan City, LA.
- e. Headquarters Building, MacDill AFB, FL.
- f. Combat Readiness Command Building, MacDill AFB, FL.
- g. Hospital Retaining Walls, Fort McClellan, AL.
- h. Expansion to Reception and Processing Center, Fort McClellan, AL.
- i. RSNF O&M Community, Riyadh, Saudi Arabia.
- j. RRNSEP Project, Jeddah, Saudi Arabia.
- k. KAMA Project, Al Batin, Saudi Arabia.
- l. University of Riyadh, Saudi Arabia.
- m. KKMC Project, Al Batin, Saudi Arabia.
- n. Dining Facility, 67th and Tank Destroyer Road, Fort Hood, TX.
- o. MEDDAC Headquarters, Fort Hood, TX.
- p. Restrooms, Temple Park, Belton Dam, TX.
- q. Receiving and Distribution Warehouse, Kelly AFB, TX.
- r. Overhaul and Test Facility (Hydraulic and Pneumatic), Kelly AFB, TX.
- s. Overhead Utility Support, Kelly AFB, TX.
- t. UEP Housing (architectural concrete upgrading), Kelly AFB, TX.
- u. Aeromedical-Evacuation Training Facility (ANG), Kelly AFB, TX.
- v. Wilford Hall Medical Center, Lackland AFB, TX.
- w. Downtown River Channel Walls, San Antonio, TX.
- x. Pumping Station, Hurricane Flood Protection System, Freeport, TX.
- y. Tide Gates Structure, Freeport, TX.
- z. Schofield Barracks, Fort Shafter, HI.

6. Projects located in the southeastern United States were visited during the period 8-12 August 1983. The visit to Saudi Arabia occurred between 17 and 31 August 1983, and the southwestern United States projects were inspected during 5-9 September 1983. Fort Shafter was visited 27 September 1983.

## Results and Discussion

7. During the visits to the sites listed above, numerous installations were inspected where the design and the workmanship were excellent. The repetitive problems which were found can be separated into three categories:

- a. Questionable design.
- b. Incomplete specifications or specifications lacking in detail.
- c. Inadequate inspection and poor workmanship.

The inspector's guide does not furnish sufficient guidance, and the inspectors do not recognize all the deficiencies.

8. In general the problems most frequently encountered with portland-cement plaster are as follows:

- a. Cracking. After application, portland-cement plaster characteristically shrinks as it dries. Unless accommodated by proper detailing at the membrane perimeter and at re-entry corners, and by contraction joints, shrinkage may produce cracks. Cracks can also be created by structural movements caused by loads, settlements, or temperature differentials. Discontinuity of large areas can be controlled by using properly installed plaster accessories. Careful consideration must be given to aggregate grading, proportions, and water-cement ratio.
- b. Color variations. Color variations show up as a lack of uniformity in the color and texture of the finish coat. These are generally caused by variations in mixture proportions and finishing procedures.
- c. Blemishes. Variations in the texture of interior surfaces are termed blemishes. These are commonly caused by poor quality plaster application and curing and by uncontrolled water contents of base coats at the time of finish coat application.

These visually offensive characteristics may or may not affect the integrity of the membrane. Although the contributing causes are numerous, the fundamentals presented here provide for a general understanding of the basic principles.

9. The following lists summarize the deficiencies which were found repeatedly. These are covered in more detail in the fact sheets which start on page 16.

a. Design problems:

- (1) Improper location of control joints.
- (2) Absence of control joints.
- (3) Lack of control joints in the concrete masonry substrate.
- (4) Radical architectural treatment.

- (5) Lack of consideration for local conditions when selecting texture and color of finish coat.
- (6) Lack of understanding of the function and placement of control joints.
- (7) Lack of understanding of curing procedures for organically modified plaster.
- (8) Sealant colors contrasting with plaster color.
- (9) Lack of construction details on plans and specifications.
- (10) Requirements for cement plaster and gypsum plaster confused in specifications.
- (11) Use of cement plaster over steel studs systems.
- (12) Confusion of terminology in specifications. (This was a problem found throughout the investigation. To clarify the situation, a recommended glossary of plastering terms has been developed and is attached hereto.)

b. Corps Guide Specifications:

- (1) Change references from ANSI 42.2 and A42.3 to ASTM C 110.
- (2) Paragraph 10.2: delete the reference to "cross scratching" and change to "score in one direction only - score vertical surfaces horizontally."
- (3) Permit application of cement plaster to solid bases such as concrete.
- (4) Paragraph 10.3: brown coat should not be scratched. The surface should be uniformly floated after straight edging to promote densification of the coat and to provide a surface receptive to bonding of the finish coat.
- (5) Paragraph 10.4: dampen base coat only once to a uniform wetness with no free-standing water before finish coat is applied.
- (6) Paragraph 5.2: delete word "stucco."
- (7) Technical notes, paragraph F; include: "in no case shall the dimensions of any area exceed a width-to-length ratio of 1 to 2-1/2."
- (8) Inconsistent use of terms "cement plaster" and "stucco."

c. Inspection:

- (1) Inspector's guide does not offer sufficient information.
- (2) Inspectors do not recognize all deficiencies.

d. Workmanship:

- (1) Improper application of lath.
- (2) Paper-backed lath not split at lap areas.
- (3) Wire lath continuous behind control joints.

- (4) Rib lath applied backside out.
- (5) Lath not discontinued at junction of vertical and horizontal surfaces.
- (6) Lath and plaster applied by unqualified personnel.
- (7) Masonry mortar joint should not be tooled if wall is to receive plaster.
- (8) Patch work done with wrong color plaster.
- (9) Plywood sheathing tightly butted.
- (10) Improper batching of plaster,
  - (a) Volume box improperly used or not used.
  - (b) Incorrect mixing sequence followed.
  - (c) Insufficient mixing time.
  - (d) Spilled cementitious materials gleaned from the ground added to mixer.
  - (e) Inconsistent quantity of sand used due to bulking.
- (11) Control joints filled with plaster.
- (12) Corner beds covered with plaster.
- (13) Improper use of accessories.
- (14) Plaster wetted during rodding and floating.
- (15) Finish coat applied with rollers.
- (16) Lack of color consistency in finish coat.
- (17) Improper fogging procedures.
- (18) Lack of curing procedures.

10. The following general procedures need to be taken into account on all portland-cement plaster installations:

- a. Quality plaster is essential to any successful installation. The plaster must develop adequate tensile strength to resist imposed stress and have sufficient resiliency to accommodate expansion and contraction. Consistency in the batching operation is as important to the development of quality plaster as ingredients and quantities.
- b. The most important ingredient is the aggregate. Aggregate should conform to specifications. The physical properties of aggregate that have the most pronounced effect on plaster are: grading, shape and denseness of the particles, and particle surface characteristics (roughness and porosity).
- c. Curing procedures play a vital role in reducing shrinkage cracking by permitting the plaster to dry slowly and uniformly. Fog curing requires a fine mist application at intervals related to job conditions. The purpose of curing is to maintain enough water within the plaster to keep the interior relative humidity above 80 percent during the specified curing period.

- d. It is acceptable to place a second coat of plaster as soon as the first coat is strong enough to withstand the pressure of the second application. When plaster is applied to a solid backing such as block, concrete, or wire lath backed with rigid sheathing, both base coats can be applied in 1 day and the finish coat on the following day. Or successive coats can be applied on consecutive days.

11. In order to avoid the deficiencies listed above and to insure that good plastering procedures are adopted on all Corps projects, the following general recommendations are offered:

- a. Additional direction should be provided in expanded Guide Specifications and Instructions to the Architect-Engineer. Additional guidance is needed on sample panels; design, location, and construction of control joints, etc.
- b. The inspector's handbook needs to be amended and expanded.
- c. Field personnel should receive training in the installation of portland-cement plaster. Such training should include proper use of sample panels, the end product to be expected, proper methods of repair, proper construction procedures, optimum mixture proportioning, and the detection of problems before they become major. Such training will provide the QA personnel the confidence required to make and implement decisions which are necessary. Training and inspector's manuals are beneficial; however, onsite training is of the most value.

### Fact Sheets

12. As a result of the field investigation, 28 repetitive deficiencies have been identified. Their causes and recommendations for prevention and possible repair procedures are included in the following fact sheets. Recommendations for prevention listed in the fact sheets which deal with revisions to guide specifications are being incorporated into the guide specifications by HQUSACE.



Plastering Procedures

## PLASTERING PROCEDURES

### Problem

Improper batching  
of plaster.

### Identification:

Inspection of mixing site may reveal haphazard procedures that do not conform to specifications.



### Cause:

Lack of quality control at mixer leads to variations in the quality of the plaster.

### Remedy:

It is essential to adhere to specifications for mixing procedures. These include:

- volumetric batching of aggregate and water.
- protection of stored aggregate.
- proper cement mixing sequence.
- time limitation on use of prepared plaster.

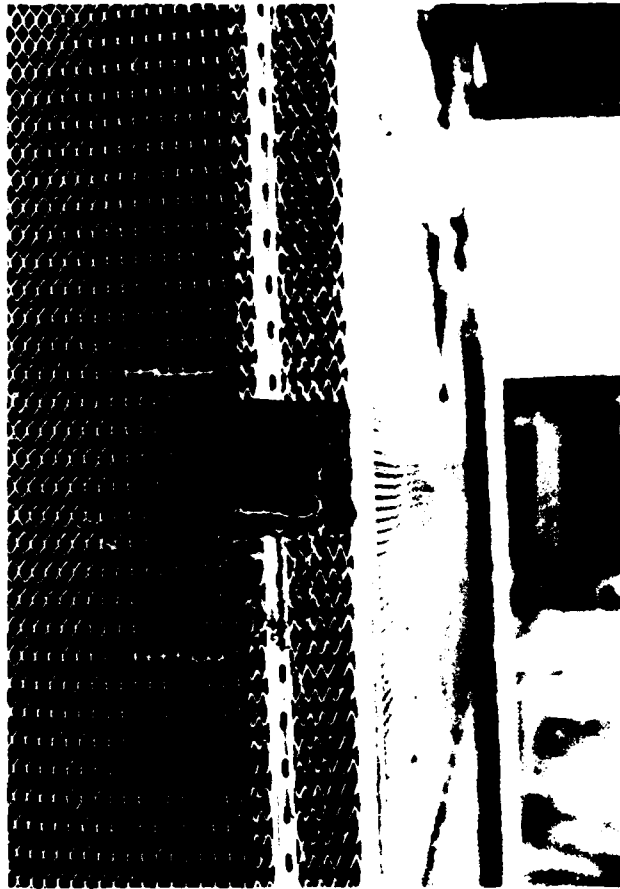
## PLASTERING PROCEDURES

### Problem:

Vertically installed lath.

### Identification:

Lath panel clearly reveals vertical rather than horizontal placement.



### Cause:

Improper installation can cause cracking.

### Remedy:

All diamond lath should be installed in a horizontal position with deformations in the lath directed upward.

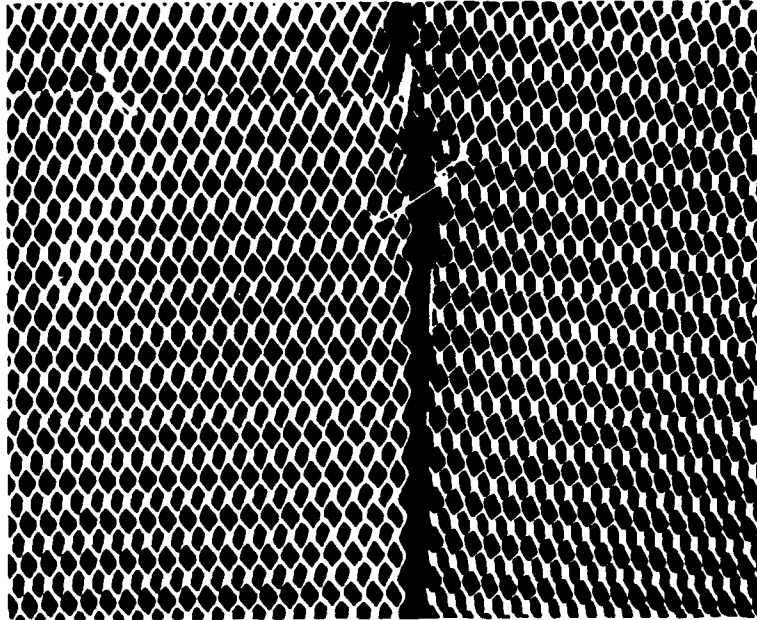
## PLASTERING PROCEDURES

### Problem:

Diamond lath not  
properly lapped.  
(Ceiling application)

### Identification:

Paper exposed due  
to failure to split paper-  
backed lath at lap joint.



### Cause:

Improper application will cause cracking.

### Remedy:

All lath must be lapped a minimum of 1/2 in. on side laps and 2 in. on end laps. When paper-backed lath is employed, the paper must be removed from one piece of lath to permit a paper-to-paper and lath-to-lath configuration in the lapped area.

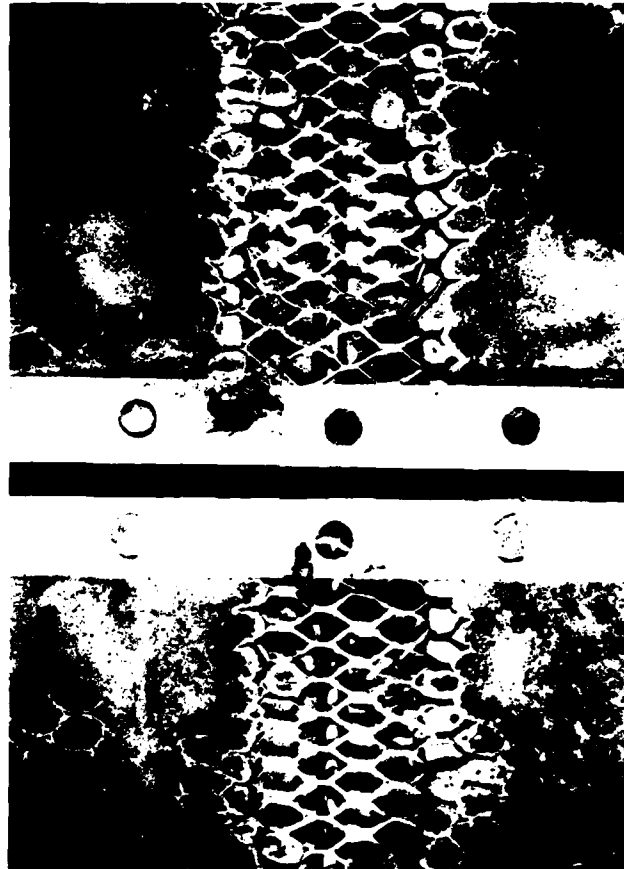
## PLASTERING PROCEDURES

### Problem:

Wire lath laid continuously behind control joint.

### Identification:

Joint reveals underlying wire mesh lath behind vertical control joint.



### Cause:

Improper installation. If the lath is not discontinued, the joint will not function and can result in cracking.

### Remedy:

All lath must be discontinued at control joints. A minimum 1/2-in. gap is desirable.

## PLASTERING PROCEDURES

### Condition:

Plywood sheathing used in conjunction with lath and plaster.

### Identification:

Inspection showed plywood sheets tightly butted.



### Problem:

Cracking can occur in a plaster membrane due to expansion of plywood sheathing.

### Remedy:

A 1/4-in. gap should be provided between all sheets of plywood. Building paper and self-furring lath or paper-backed lath should be installed. Plywood should be covered in storage and covered with building paper when applied to the structure to prevent wetting. Proper nailing is important.

## PLASTERING PROCEDURES

### Problem:

Voids or holidays  
in scratch coat.

### Identification:

A pocked surface  
of the scratch coat  
that reveals underlying  
lath.



### Cause:

Scoring too deeply or insufficient thickness of plaster or both. Deep scratching can induce cracking that will reflect through succeeding coats.

### Remedy:

The scratch coat must cover all lath with sufficient depth to allow for light scratch that will not penetrate to lath.

## PLASTERING PROCEDURES

### Problem:

Exposed lath.

### Identification:

Base material underlying the plaster is revealed in area of control joint.



### Cause:

Improper application techniques do not provide adequate plaster coverage for lath.

### Remedy:

All lath must be covered by a scratch coat. Scratch vertical surfaces in horizontal direction only.



## PLASTERING PROCEDURES

### Problem:

Brown coat of a three-coat application is scored.

### Identification:

Scoring does not conform to proper procedures. Texturing sequence for plaster layers is incorrect.



### Cause:

Improper scoring of brown coat.

### Remedy:

Proper application procedures require that only the first coat be scratched and scoring should be horizontal. The second coat (brown) should receive a rough float texture only.

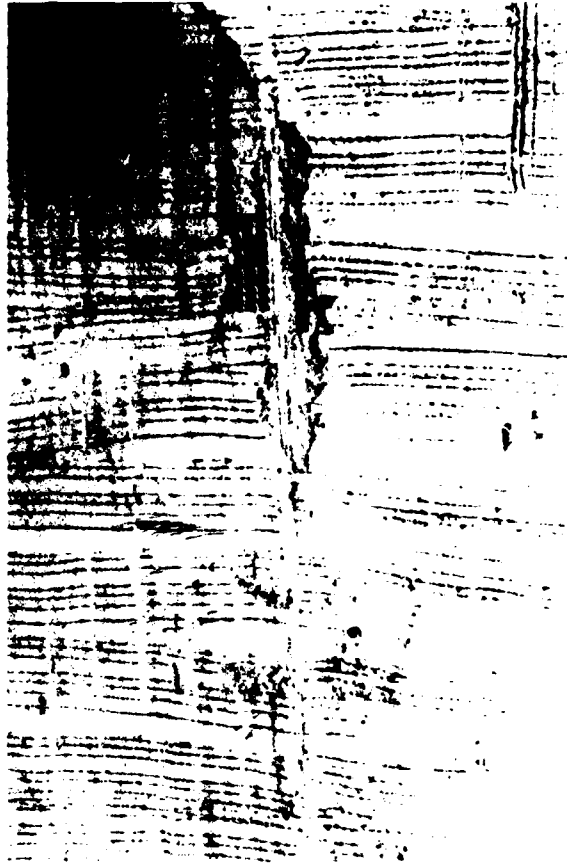
## PLASTERING PROCEDURES

### Problem

Scaling of brown coat. Control joint covered with plaster.

### Identification:

Flaking or peeling occurs on the near-surface portion of the plaster.



### Cause:

Scaling is caused by rapid drying of the plaster, which is an unacceptable technique, violative of curing requirements.

### Remedy:

Qualifications of the applicator are questionable and should be investigated.

Cracking

## CRACKING

### Problem:

Cracks that occur at regular intervals.

### Identification:

Cracks appear in almost a geometric pattern.



### Cause:

Shrinkage cracks are commonly caused by lack of curing, improper curing, or over-troweling, or combinations thereof.

### Remedy:

Curing procedures should maintain relative humidity within the plaster above 80 percent for 24 to 48 hr after application. Fog spraying should be applied as frequently as needed. Fogging two or three times a day may or may not be adequate.

When organic modified plaster is used, the curing procedure may require air rather than moist curing.

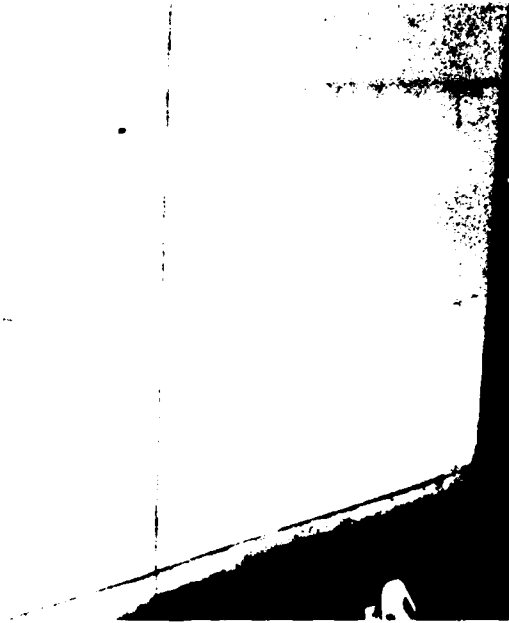
## CRACKING

### Problem:

Grid cracking.

### Identification:

Horizontal crack-  
ing appears along the  
lath lines.



### Cause:

Lath has been improperly tied or lapped or both.

### Remedy:

Inspection should ensure compliance with the tying and lapping schedule.

## CRACKING

### Problem:

Cracking along control joint.

### Identification:

A deep surface crack clearly runs parallel to the control joint.



### Cause:

The control joint has been improperly installed.

### Remedy:

Lath must be discontinued behind control joints.

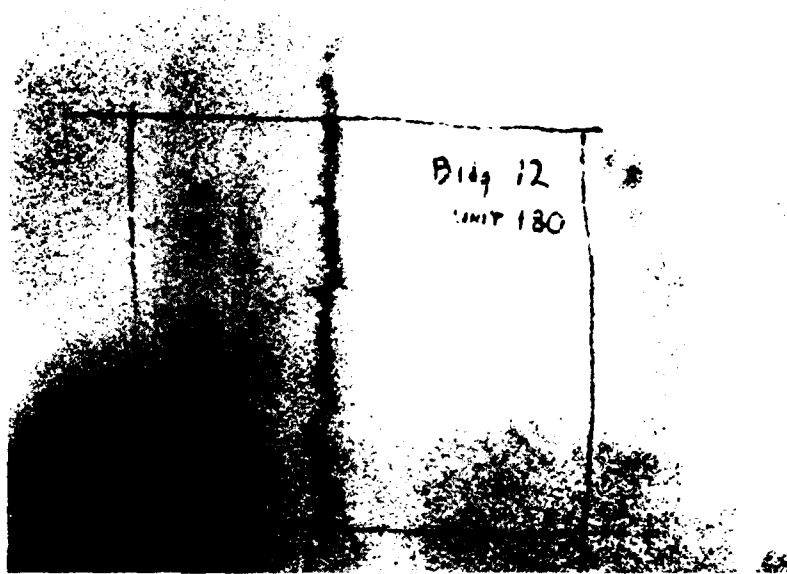
## CRACKING

### Problem:

Cracks occurring  
at studs.

### Identification:

Inspection shows  
studs at location of  
cracks.



### Cause:

Concurrence of studs and cracks takes place because stresses find relief at the thinnest plane of the membrane. Other causes are:

- deflection of studs under load,
- deflection from wind load while the plaster is weak,
- application of the interior finish while plaster is weak.

### Remedy:

The problem is avoided by proper installation of control joints and furring out the lath from the studs to develop a uniform thickness of plaster.

Other successful construction practices include:

- reduced spacing or an increase in stud size,
- adequate bridging or the application of interior facing material before applying plaster.

Also, an adequate construction schedule should be maintained.

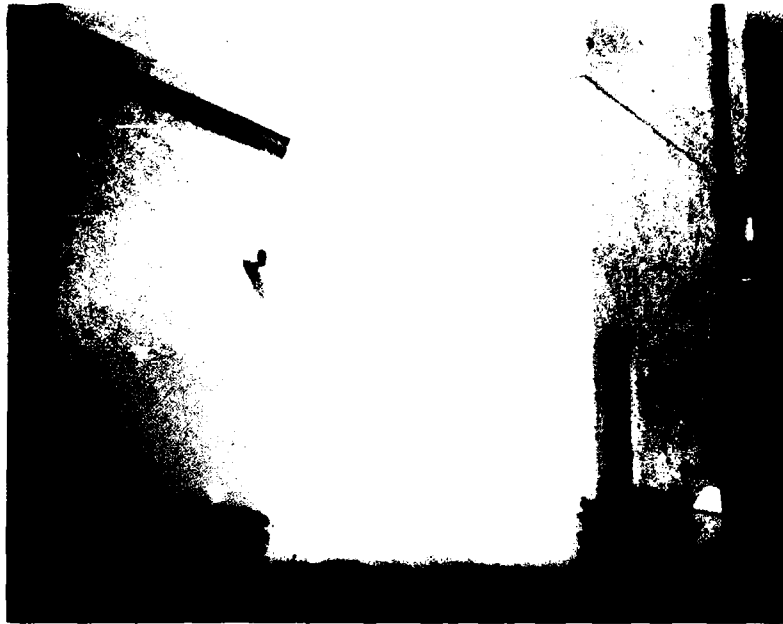
## CRACKING

### Problem:

Extensive random cracking in plaster membrane.

### Identification:

A network of large, widely spaced cracks appears on wall surfaces.



### Cause:

There are no control joints because stresses were not anticipated. The designer felt that control joints detracted from appearance.

### Remedy:

Control joint spacing in open frame construction (wood or metal studs) should not exceed an area of 144 sq ft or 15 ft in any one direction, and length to width ratio cannot be more than 2-1/2 to 1. Note that the size of areas between cracks in the photograph assumes a 2-1/2 to 1 dimension or squares.



## CRACKING

### Problem:

Random cracking.

### Identification:

Cracking is irregular and has no pattern.



### Cause:

A number of irregularities could be responsible including differential shrinkage or expansion between the plaster membrane and backing, or between individual plaster coats. This type of cracking is also characteristic of water-saturated plywood sheeting.

### Remedy:

The situation can be corrected with a uniformly strong bond and minimization of differential movement between membrane and backing and between individual coats within the membrane. Adherence to proportioning specifications, quality control at the mix site, and good application techniques are required. Use paper-backed lath when applying wire lath, and plaster over absorptive concrete masonry walls to prevent bonding.

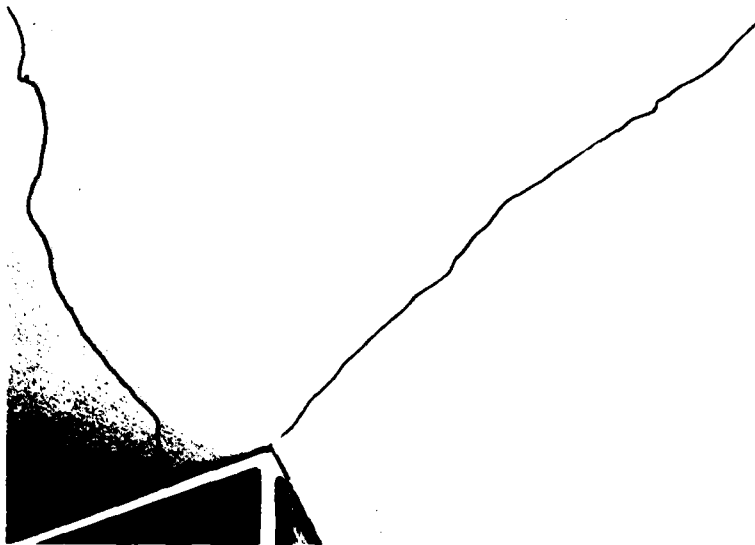
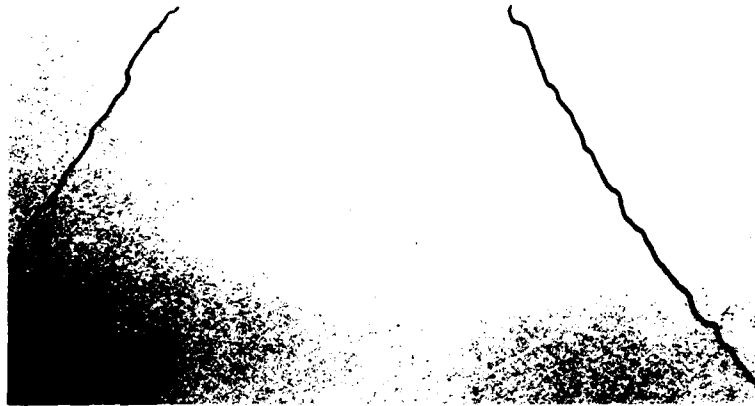
## CRACKING

### Problem:

Crack radiating from light fixture and building corner in a plastered ceiling.

### Identification:

Crack location is a good indicator of the problem since it consistently appears at corners.



### Cause:

Cracking resulted from improper location of control joints. Joints were placed several feet from the fixture and from corners.

### Remedy:

The ceiling should be properly divided by control joints in sections not to exceed 144 sq ft. Light fixtures are installed in line with joints. The building lines should be extended through the ceiling with control joints.

## CRACKING

### Problem

Cracking in plaster adjacent to control joint in insulated concrete masonry cavity wall.

### Identification:

Fine cracks run closely parallel to control joints.



### Cause:

The control joint in the plaster was not installed directly over the control joint in the concrete masonry. Too few control joints were built into the wall to allow for higher-than-normal temperatures that developed in exterior wythe of the concrete masonry. It is also possible that control joints were improperly constructed.

### Remedy:

Control joints must be placed in the plaster membrane directly over all joints in the wall. Allowance must be made for greater movement in exterior wythe when the cavity is insulated. The control joint must sever the entire membrane, not just the finish coat.

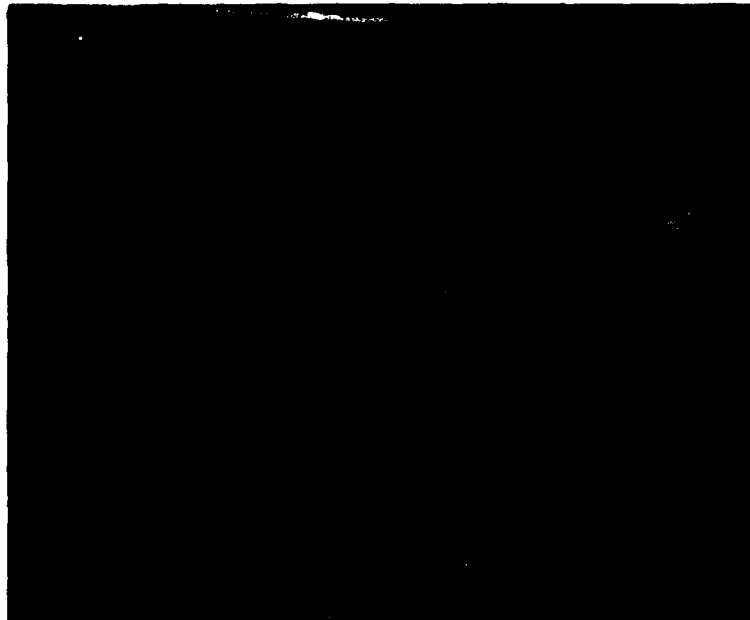
## CRACKING

### Problem

Extensive fine cracking.

### Identification:

An irregular network of fine cracks covers the wall surface.



### Cause:

A very weak plaster resulted when designed as a lime plaster with little portland cement content. Aggregate was excessively fine. (High cement-low aggregate proportions also can cause plaster problems. High contents of cementitious materials can also cause plastic shrinkage.)

### Remedy:

Plaster must have adequate strength to resist stresses induced by dimension changes.

## CRACKING

### Problem

Craze cracking.

### Identification:

A pattern of fine random cracks appears in the plaster surface.



### Cause:

Over-troweling or over-floating creates a cement-rich surface that leads to cracking.

### Remedy:

Delay finishing until material has hardened sufficiently to resist migration of fines to the surface.

## CRACKING

### Problem

Separation of casting bead at window jamb.

### Identification:

Cracking and deterioration occur at juncture of window jamb and plaster.



### Cause:

Improperly installed accessory.

### Remedy:

All accessories must be tied to the lath system at proper intervals and must be keyed with the same plaster as in the field.

## CRACKING

### Problem

Building contains excellent control joint spacing but plaster is still cracking.

### Identification:

A long vertical crack has appeared that runs nearly top to bottom on the exterior wall.



### Cause:

An arched opening or penetration has the same effect as a rectangular opening and requires a control joint. In this case the joint was improperly located.

### Remedy:

A control joint should be placed at the top of the arch and a horizontal joint at the base of projecting detail.

## CRACKING

### Problem:

Cracking of gypsum plaster in open frame construction.

### Identification:

Cracking of gypsum plaster corresponding to joints in lath.



### Cause:

Both sides of the wall were exposed to excessive and uncontrollable drafts, low humidity, and high temperatures.

### Remedy:

Fiberglass mesh should be installed at all horizontal joints of the lath.



Color Variations

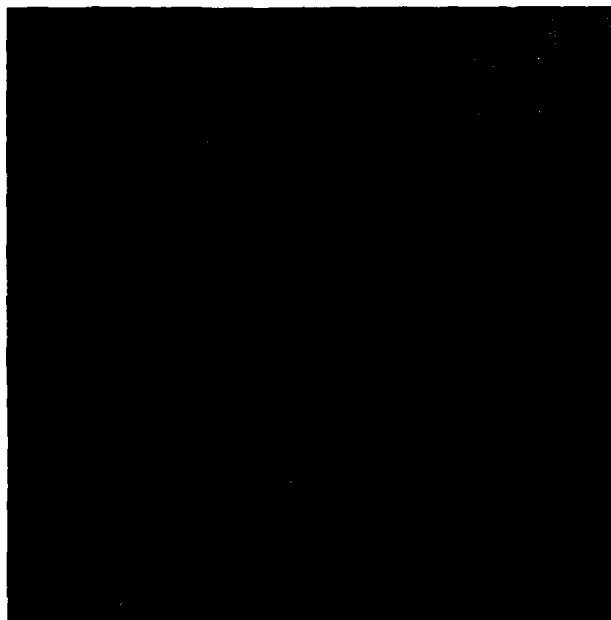
## COLOR VARIATIONS

### Problem:

Color variation.

### Identification:

Color is muddy and irregular.  
A blotchy appearance does not conform to specifications.



### Cause:

Uneven color in the finish coat usually is caused by variations in water content. High water content in the plaster raises fines, such as cement, pigments, or impurities found in the aggregate, to the surface. Excess water can be introduced while batching the plaster, or brought into the plaster by nonuniform or excessive wetting of the base, a rain-saturated base or finish coat, over-troweling, premature troweling, blending cold joints in the finish coat, improper curing procedures, excessively wet aggregate, variations in pigment content, a change in the aggregate or cement source, or uneven dirt deposits on the surface.

### Remedy:

Quality workmanship and adherence to quality control practices that recognize conditions that affect color variations are required.

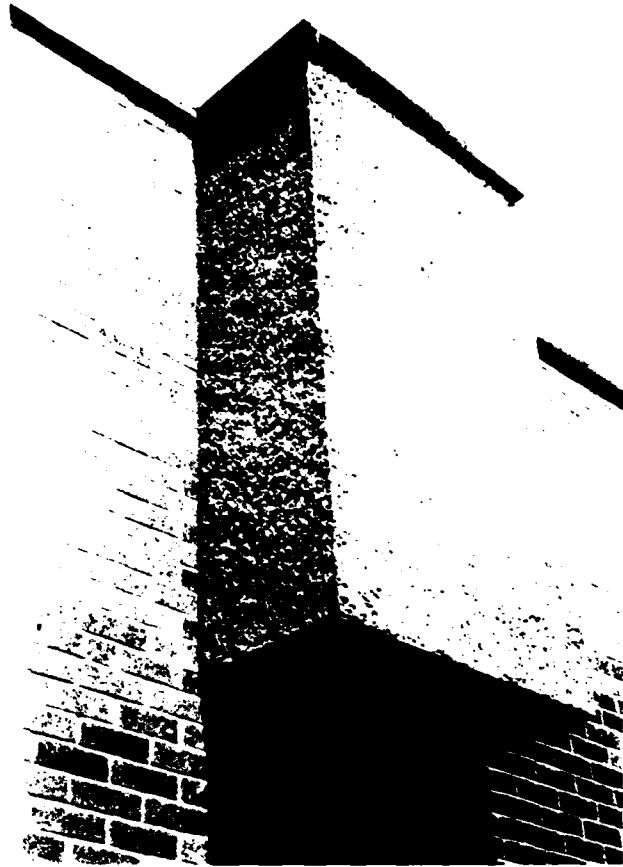
## COLOR VARIATIONS

### Problem:

Uneven texture of exposed aggregate.

### Identification:

An uneven depth of setting plaster and a nonuniform application of aggregate.



### Cause:

The applicator was inexperienced or was given improper guidance.

### Remedy:

Erecting a preconstruction sample panel, built vertically and of sufficient size, will indicate what to expect of the finished product. A panel size of 4 ft wide and a minimum of 6 ft high is suggested.

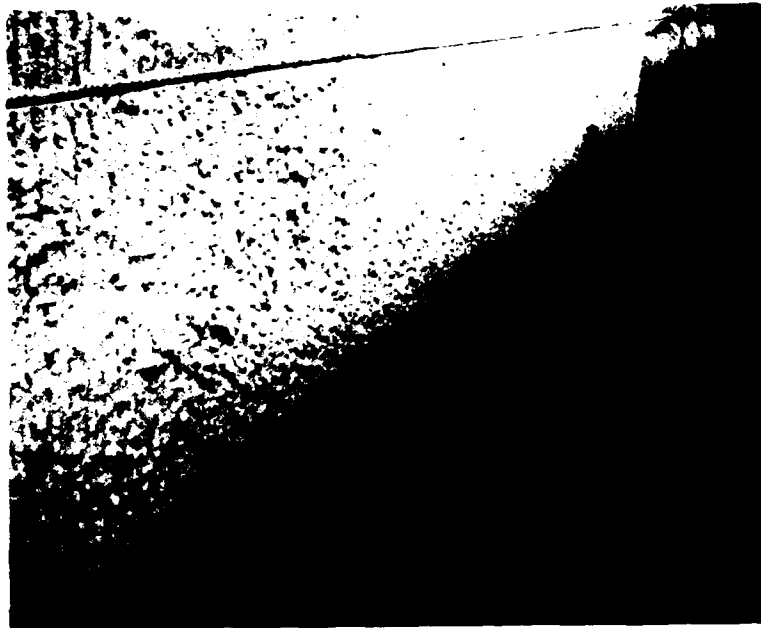
## COLOR VARIATIONS

### Problem

Discoloration of plaster.

### Identification:

Plaster clearly is stained because of the effect of surroundings.



### Cause:

A white, coarsely-textured finish coat was used in an open area subject to blowing dust and rain splatter.

### Remedy:

A designer should always consider location and maintenance requirements when specifying the color of the finish coat.

Blemishes

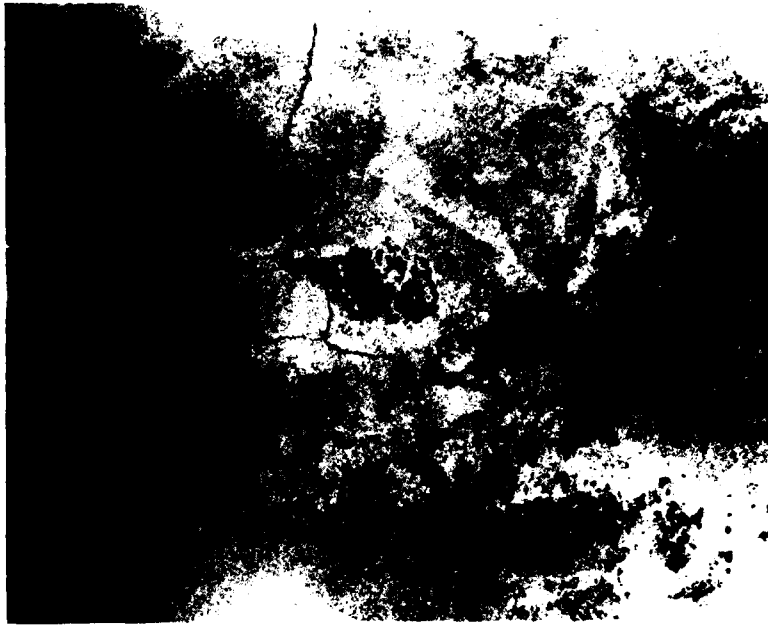
## BLEMISHES

### Problem:

Blemishes and cracking.

### Identification:

"Catfaces" and fine cracks are the problem indicators.



### Cause:

Cracks were caused by over-troweling in an attempt to achieve a smooth trowel finish. The problem was compounded by poor curing practices, excessive draft, and poor leveling of the brown coat. Blemishes are slight depressions called "catfaces" resulting from inability of applicator to attain a flat surface. The flaws can be caused by lack of skill, an uneven base coat, uneven prewetting of the base coat, or delayed finishing.

### Remedy:

A change of application and curing procedures is required.

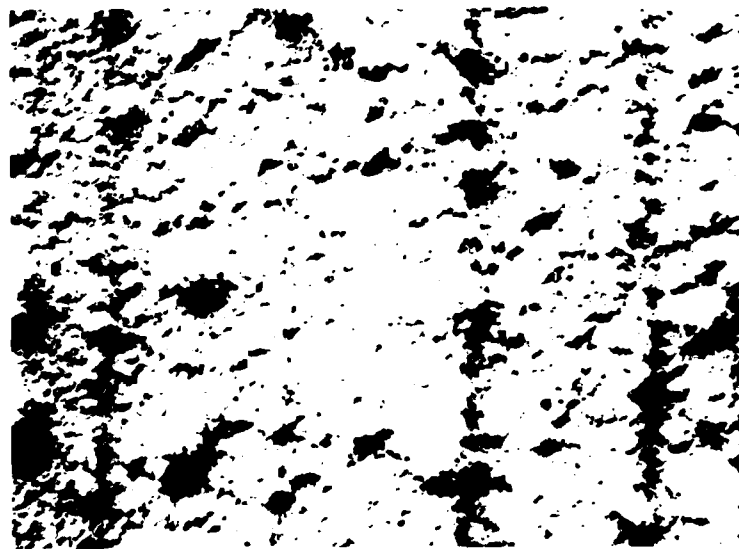
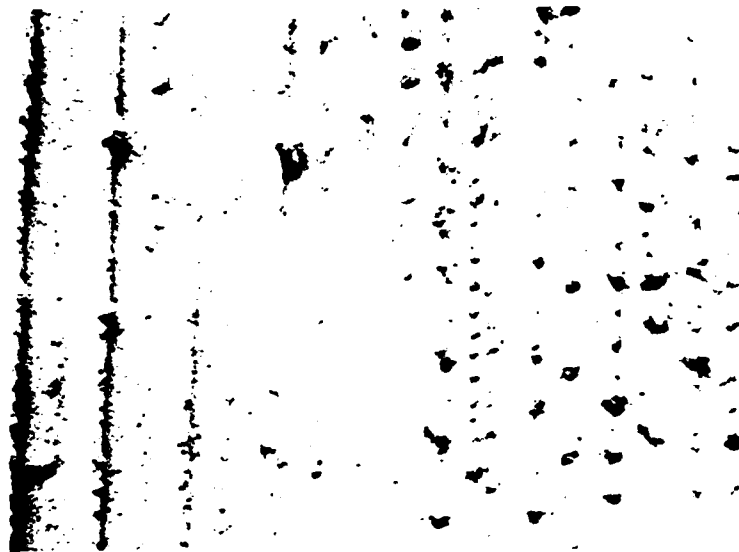
## BLEMISHES

### Problem:

Variations in texture.

### Identification:

Discontinuity in texture is usually accompanied by some color variation.



### Cause:

Inaccurate timing when texturing, either delayed or premature procedures, causes variation.

### Remedy:

A uniform consistency of plaster, uniform moisture content of base, and texturing only when plaster has properly stiffened will prevent texture and color irregularities.

## Glossary of Plastering Terms

Accelerator. An admixture that speeds the rate of hydration of hydraulic cement, shortens the time of setting, or increases the rate of hardening, of strength development, or both, of portland cement plaster.

Acid etching. The cleansing and controlled erosion of a solid surface, using an acid wash.

Addition (improperly called additive). A substance that is interground or blended in limited amounts into a hydraulic cement during manufacture -- not at the jobsite -- either as a processing addition to aid in manufacturing and handling the cement or as a functional addition to modify the use properties of the cement.

Admixture. A material, other than water, aggregate, lime, fiber reinforcement, and hydraulic cement, used as an ingredient of plaster and added to the batch immediately before or during mixing.

Aggregate. A granular material such as natural sand, manufactured sand, vermiculite, or perlite.

Air-entraining capacity. The capability of a material or process to develop a system of minute bubbles of air in cement paste, or plaster during mixing.

Air-entraining agent. An addition for hydraulic cement or an admixture for plaster that will cause air to be incorporated in the form of minute bubbles in the plaster during mixing, usually to increase its workability and frost resistance.

Air-entraining hydraulic cement. Hydraulic cement containing an air-entraining addition in an amount that will cause the cement to entrain air in plaster within specified limits.

Air entrainment. The intentional introduction of air in the form of minute, disconnected bubbles (generally smaller than 1 mm) during mixing of portland



cement plaster to improve flow and workability or to impart other desired characteristics to the plaster.

Back plastering. Applying a backup coat (or coats) of plaster to the back side of a solid plaster partition after the scratch (first) coat has been applied and has set on the lathed side.

Base coat. The total of all plaster coats applied prior to application of the finish coat; where more than two layers of plaster are applied, the first application is called the scratch coat and the second called the brown coat; the combined first and second coats are called the base coat.

Base screed. A preformed metal screed with perforated or expanding flanges that provides a ground for plaster and separates areas of dissimilar materials.

Batching. Weighing or volumetrically measuring and introducing into the mixer the ingredients for a batch of plaster.

Bead. A strip of sheet metal usually formed with a projecting nosing and two perforated or expanded flanges; that serves to establish plaster ground while the flanges provide for attachment to the plaster base; used at the perimeter of a plaster membrane as a stop or at projecting angles to define and reinforce the edge; types include corner beads, casing beads, base beads, etc.

Bedding coat. A plaster coat that receives aggregates or other decorative material impinged into its surface before it sets.

Binders. Cementing materials, either hydrated cements or products of cement or lime and reactive siliceous materials; the cement type and curing conditions govern the binder formed.

Bleeding. The flow of mixing water within, or its emergence from, newly applied plaster -- caused by gravitational settlement.

Blistering. Protuberances on a coat of plaster during or soon after the finishing operation; also bulging of the finish plaster coat where it separates and expands away from the base coat.

Block. A concrete masonry unit.

Bond. Adhesion of plaster to other surfaces against which it is applied; adhesion of cement paste to aggregate; adherence between plaster coats or between plaster and a substrate. (See "Chemical Bond" and "Mechanical Bond.")

Bondbreaker. A material used to prevent adhesion of newly placed plaster to the substrate.

Bond strength. The degree of adhesion developed between plaster and a substrate; the resistance to separation of plaster from other materials in contact with it.

Bonding agent. A compound applied as a coating to a suitable substrate to create a bond between it and a succeeding layer, as between a subsurface and a succeeding plaster application; also a compound used as an admixture to increase adhesion at the plaster substrate interface and increase adhesion and cohesion of the plaster.

Brown coat. The second coat of three-coat plastering.

Brown out. To complete application of a base coat.

Carbonation. Reaction between carbon dioxide and a hydroxide to form a carbonate, especially in cement paste or plaster; the reaction with calcium hydroxide that produces calcium carbonate.

Catface. Blemishes or rough depressions in finish plaster comparable to pockmarks.

Cement, hydraulic. Any cement, such as portland cement, that will set and harden due to the chemical reaction with water, and is able to do so under water.

Cement paste. A mixture of hydraulic cement and water, both before and after setting and hardening.

Checking. Development of shallow cracks at closely spaced but irregular intervals in the plaster surface.

Chemical bond. Adhesion between dissimilar materials or between one plaster coat and another that is the result of a chemical reaction.

Coat. A film or layer, or a thickness of plaster, applied in a single operation.

Cohesion. The ability of a material to cling to itself.

Consistency. The relative mobility or ability of freshly-mixed plaster to flow.

Contact ceiling. A ceiling with metal lath attached in direct contact with the construction above without use of runner channels or furring.

Control joint. A weakened plane in the plaster surface created by a formed metal section or tooled groove; that limits the areas of unbroken plaster surfaces to avoid the development of high stresses and regulate the location of possible cracking due to expansion, contraction, and initial shrinkage of the plaster; and also minimizes cracking caused by settlement, subsidence, and minor earth tremors.

Cold joint. ("joining" or "jointing") The juncture of fresh plaster application adjacent to set plaster.

Corner reinforcement. Metal reinforcement for plaster used at corners to provide continuity between two intersecting plaster planes.

Corrosion. Disintegration or deterioration of metal reinforcement due to electrolysis or chemical attack.

Craze cracks. Fine, random cracks or fissure, that may appear in a plaster surface, caused by shrinkage. (See "Checking.")

Cross furring. Term used to denote furring members attached to other structural components to support lath in suspended ceilings.

Cross scratching. Scratching of the first coat in two directions to provide a mechanical bond between coats as is common in gypsum plaster use; not recommended for the first coat of portland cement plaster, which should be scored lightly (in a horizontal direction only) on vertical wall surfaces.

Curing. Keeping freshly applied plaster moist and at a favorable temperature for a suitable length of time following application to assure satisfactory hydration or carbonation of the cementitious materials and proper hardening of the plaster.

Curling. The distortion or warping of an essentially planar surface into a curved shape, owing to several factors such as creep or temperature and moisture differences within the plaster coat.

Darby. A flat wooden or magnesium-alloy tool with handles, approximately 45 in. (1140 mm) long, used to dress or float the second (brown) coat of plaster.

Dash-bond coat. A thick slurry of one part portland cement mixed with one to two parts fine sand plus sufficient water to make a mixture that can be dashed by hand or machine onto concrete, masonry, or older plaster surfaces, to provide a mechanical bond for succeeding plaster.

Dash texture. A finish coat of thick cement plaster hand-dashed or machine-blown onto a well-prepared, uniformly plane surface of brown-coat plaster. (Also called spatterdash.)

Diamond mesh. One of the common types of metal lath having a characteristic geometrical pattern produced by slitting and expansion of metal sheets.

Discoloration. Change in color from the normal or desired.

Dope. A term used by plasterers for additives of any type used to retard or accelerate set of plaster.

Double-back or double-up coat. Application of second coat of plaster to the first or scratch coat immediately after first coat has attained sufficient rigidity to receive it.

Durability. The ability of portland cement plaster to resist weathering action, chemical attack, abrasion, and other service conditions.

Earth pigments. The class of pigments produced by physical processing of materials mined directly from the earth; also frequently called natural or mineral pigments or colors.

Efflorescence. A deposit of salts, usually white, formed on a surface, the substance emerging in solution from within the plaster and deposited by evaporation.

Entrapped air. Unintentional air voids in the plaster, generally larger than 1 mm.

Expanded metal lath. Sheets of metal that are slit and pulled out to form diamond-shaped openings, used as metal reinforcement for plaster.

Factory prepared. ("mill-mixed" or "ready mixed") -- pertaining to material combinations that have been formulated and dry-blended by the manufacturer, requiring only the addition of and mixing with water to produce plaster.

Fattener. See plasticizer.

Featheredge. A wood or metal tool with a beveled edge and varying in length; used to straighten re-entrant angles in finish plaster coat. Also used to plane the surface of the brown coat and dry rod or dry rake it to better control color in the finish coat.

Fiber, natural or synthetic. An elongated fiber or strand admixture added to plaster mixture to improve cohesiveness or pumpability, or both.

Fines. Pertaining to small aggregate particles capable of passing a 75- $\mu$ m (No. 200) sieve.

Fine aggregate. Sand or other inorganic aggregate in a range that passes the 4.75-mm (No. 4) sieve and is predominantly retained on the 75- $\mu$ m (No. 200) sieve.

Finish coat. The last coat of plaster, the decorative surface; usually is colored and frequently is textured.

Float. A rectangular tool consisting of a handle attached to a base pad of molded rubber, foam plastic, cork, wood, or felt tacked to wood and used to impart a relatively even but still open texture to a plaster surface -- generally second hand third-coat plasters.

Floating. Act of compacting and levelling brown-coat plaster, to a reasonably true surface plane using a float and the act of bringing the aggregate to the surface of finish-coat plaster.

Fog coat. A light coat of cement and water, with or without aggregate or color pigment, applied by machine spray to improve color consistency.

Furring. Space elements used to maintain a space between the plaster and the structural element behind it.

Grading. The size distribution of aggregate particles, determined by separation with standard screen sieves. (Often improperly called "gradation.")

Hairline cracks. Very fine cracks in either random or essentially straightline patterns that are just visible to the naked eye. (See "Checking.")

Harsh mixture. A mixture that lacks desired workability and consistency due to a deficiency of cement paste, aggregate fines, or sufficient water.

Hawk. A tool to hold and carry plaster; generally a flat piece of metal approximately 10 to 14 in. (250 to 350 mm) square, with a wooden handle fixed to the center of the underside.

Hydrated lime. A product produced when water is added to quicklime by any one of the following processes: pressure hydration, atmospheric hydration, or slaking.

Hydraulic cement. See "Cement, hydraulic."

Joining. Sometimes termed jointing, denotes the juncture of two separate applications usually within a single surface plane.

Key. (also mechanical key) Plaster that physically surrounds, penetrates, or deforms to lock onto the perforations or irregularities of the plaster base or previous coat of plaster.

Main Runners. The heaviest integral supporting members in a suspended ceiling.

Map cracking. See "Craze cracks."

Mechanical Application. Plaster applied by pumping and spraying.

Mechanical bond. The physical keying of one plaster coat to another coat; or to the plaster base by means of plaster keys to metal lath; or through interlock between adjacent plaster coats created by scratching the surface in a horizontal direction across walls and at right angles to ceiling supports.

Metal lath. Metal lath is slit and expanded or stamp-punched from plain or galvanized steel coils or sheets. It is of two types: diamond mesh, which may be flat or self-furred with impressed indentations, and rib lath; it is coated with a rust-inhibiting paint after fabrication or is galvanized.

Moisture movement. The migration of moisture through a porous medium, caused by an imbalance as surface moisture is lost through evaporation; differences in moisture within plaster thickness are responsible for crazing, distortion, etc.

Nozzle. Attachment at discharge end of delivery hose used for the machine application of plaster; it allows adjustment of the fan or spray pattern.

Nozzleman. Workman who manipulates the nozzle and controls plaster placement.

Plaster. Portland cement-based cementitious mixture.

Plaster thickness. See "Thickness, plaster."

Plasticity. A complex property of plaster involving a combination of qualities of mobility and magnitude of yield value; that property of freshly-mixed plaster that determines its resistance to deformation or its ease of molding.

Plasticizer. An admixture that increases the plasticity of a portland-cement plaster; includes hydrated lime or lime putty, air-entraining agents, and fatteners.

Retardation. Slowing down the rate of hardening or setting, usually in hot weather, to gain an increase in the time required to reach initial and final set or to develop early strength of fresh plaster.

Retarder. An admixture that delays the setting of cement paste and hence of plaster.

Retempering. Adding water and remixing plaster that has started to stiffen.

Rod. Name used by the trade for a straightedge used to straighten the face of walls and ceilings by cutting off excess plaster to the plane established by forms, ground wires, or screeds.

Rustication. (also "break") An interruption or change in plane of a plastered surface.

Sand. See "Fine aggregate."

Scarifier. A tool with flexible steel tines used to scratch or rake the unset surface of a first coat of plaster.

Scoring. Grooving, usually horizontal, of the scratch coat to provide mechanical keys with the brown coat.

Scratch coat. First coat of plaster applied to a surface in two- or three-coat plastering work.



Screeds. Devices or materials passed across the base surface of a wall or ceiling to serve as a thickness and alignment guides.

Self-furring. Metal lath or wire lath formed during manufacture to include raised portions of the lath, ribs, or dimples that hold the lath away from the supporting surface and position it for embedding in the plaster.

Set. The change in plaster from a plastic, workable state to a solid, rigid state.

Spatterdash. See "Dash texture."

Suction. The capacity for absorption possessed by a substrate or plastered surface; it may be beneficial in developing bond between coats of plaster or of plaster to a base.

Temper. To mix or restore unset plaster with water to a workable consistency.

Texture. Any surface appearance as contrasted to a smooth surface.

Thickness, plaster. Plaster thickness as measured from the back plane of metal reinforcement (or from the face of solid backing or support) to the specified plaster surface, either scratch, base, or finish).

Trowel. A flat, broad-blade steel handtool used to apply, spread, shape, and smooth-finish portland cement plaster.

"Turtle Back". A term often used synonymously with blistering. Also used to denote a small localized area of craze-cracking.

Warping. A deviation of a wall surface from its original shape, usually caused by temperature or moisture differentials, caused by an excessively rich (high-strength) mix in the finish coat or by excessive troweling to produce a smooth finished surface. (See "Curling.")

Wire-mesh lath. Plaster reinforcement available in two types, woven wire and welded wire; woven wire is made of galvanized wire woven or twisted to form either squares or hexagons, welded wire is zinc coated and electrically welded to all intersections; either type may be paperbacked.

Workability. The property of freshly-mixed plaster that determines its working characteristics and the ease with which it can be mixed, placed, and finished.

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